THE *GLYCASPIS* SPP. (HOMOPTERA : PSYLLIDAE) ASSOCIATED WITH *EUCALYPTUS CAMALDULENSIS*

K. M. Moore*

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Synopsis

The distributions of three *Glycaspis* spp. populations associated with *Eucalyptus camaldulensis* are illustrated and the distinctive lerp typical of two of the species is figured.

Additional information on the previously recorded distributions and hosts of other *Glycaspis* spp. is given.

Previous studies on the *Glycaspis* spp. associated with *E. camaldulensis* suggested that the three psyllid species which utilise this plant species as host might indicate that the species *E. camaldulensis* consists of more than a single taxon.

The present intensive study of the relevant *Glycaspis* spp., their distributions and host plant associations, indicates that the effects of temperature apparently exert limitations on the distribution of the three species, although there is some broad correspondence between the distributions of these psyllid species and the races of their host eucalypt.

Introduction

The species *Eucalyptus camaldulensis* Dehnh. has been considered as consisting of a single species (Blake, 1953), of a single species and five varieties (Blakely, 1955), and currently of a single species consisting of two subspecies (Pryor and Johnson, 1971).

These differing interpretations of the species, and the general interest shown by workers in various disciplines (Banks and Hillis, 1969 ; Pryor and Byrne, 1969) suggested that a more comprehensive evaluation of the associated psyllids, *Glycaspis blakei* Moore, *G. brimblecombei* Moore and *G. eremica* Moore, throughout the range of distribution of their host plant, might provide information of value in any taxonomic reassessment of the host.

Banks and Hillis (1969) established an intermingling of their " northern " and " southern " chemotaxa of *E. camaldulensis* in four widely separated localities. An intermingling of two of the three *Glycaspis* spp. associated with this species as host, over an extensive area, had also been determined (Moore, 1970*b*, 1972). It was therefore decided to examine more extensively the distributions of the three *Glycaspis* spp. during this project, and attempt to determine whether nymphs of each of the species surviving to the adult stage, utilised different trees of *E. camaldulensis*, or completed their life cycle on the same tree.

These investigations included that portion of the *E. camaldulensis* distribution encompassed by the Central Australia–Lake Eyre river drainage systems, together with the three psyllid species previously found to be associated with that plant as host.

Methods

Lerps were collected, and nymphs reared to the adult stage, from a number of localities, particularly in the area where the distributions of *G. blakei* and *G. brimblecombei* were known to overlap. Lerps on portions of leaves from selected trees were held in containers for up to 12 days and were examined daily. Adults bred from these nymphs and lerps were preserved for examination and determination of the species.

Net collections of *Glycaspis* spp. were made at 65 collection sites (Fig. 1 and Table 1), and details of the lerp shapes observed at each site were also recorded.

* Statue Bay, M/S 76, Rockhampton, Queensland, 4700.

TABLE 1

Collection localities for Glycaspis *spp. Sites 1–64 : collections from* Eucalyptus camaldulensis. *Site 65 : collections from* Eucalyptus tereticornis.

Site No.	Location	River or Creek	Lerps Present	Species	Number of Specimens
1	16·7 mls. N. Wentworth	Darling River	O R	*brimblecombei*	1
				amnicola	15
2	31·5 mls. N. Pooncarie	Darling River	O R	*brimblecombei*	3
				amnicola	5
3	42 mls. E. Broken Hill	Stephen Creek	C	*eremica*	21
4	16 mls. W. Broken Hill	Umberumberka Creek	C	*eremica*	13
5	Menindee	Darling River	O R	*brimblecombei*	15
				amnicola	14
6	8 mls. S. Wilcannia	Darling River	O R	*brimblecombei*	14
				amnicola	6
7	12 mls. N. Wilcannia	Darling River	?O R	*brimblecombei*	13
				amnicola	2
8	Tilpa	Darling River	C O R	*brimblecombei*	22
				amnicola	1
9	Louth	Darling River	C R	*brimblecombei*	18
				blakei	5
10	14 mls. S. Bourke	Darling River	C?O R	*brimblecombei*	18
				blakei	1
11	12 mls. E. Milparinka	Warratta Creek	C	*eremica*	4
12	9 mls. W. Milparinka	Depot Glen	C	*eremica*	29
				brimblecombei	5
				blakei	1
13	Wompah Gate	Yalpunga Creek	C O R	*eremica*	5
				brimblecombei	13
				blakei	1
14	7·3 mls. W. Warri Gate	Stoney Creek	?	*eremica*	6
				brimblecombei	1
				blakei	1
15	9 mls. NE. Innamincka	Cullyamurra Waterhole Cooper's Creek	O R	*brimblecombei*	6
				blakei	1
16	9 mls. N. Innamincka	?	C O R	*eremica*	2
				brimblecombei	2
17	40 mls. N. Innamincka	Patchewara Creek	?	*brimblecombei*	7
				blakei	2
18	23 mls. S. Cordillo Dns.	?	C R	*brimblecombei*	8
				blakei	3
19	44 mls. N. Cordillo Dns.	?	O R	*brimblecombei*	2
				blakei	1
				eremica	1
20	Copley	Leigh Creek	C	*eremica*	23
21	33 mls. N. Leigh Creek	?	C	,,	28
22	22 mls. NW. William Creek	Anna Creek	C	,,	11
23	Edwards Creek	Edwards Creek	C O	,,	38
24	11 mls. S. Oodnadatta	Allandale Homestead	C O	,,	11
25	89 mls. W. Oodnadatta	?Evelyn Creek	C	,,	19
26	61 mls. N. Welbourne Hill	?Alberga River	C	,,	14
27	75 mls. N. Welbourne Hill	Tarcoonyinna Creek	C	,,	5
28	5 mls. N. DeRose Hill	The Marryatt River	C	,,	43
29	Mt. Olga (Valley of Winds)	Bubia Creek	C O	,,	24
30	Kings Canyon	Kings Creek	C	,,	36
31	31 mls. E. Wallarah	Palmer River	C	,,	50
32	Henbury	Finke River	C	,,	13
33	57 mls. S. Alice Springs	Hugh River	C	,,	19
34	Alice Springs	Todd River	C	,,	36
35	47 mls. E. Alice Springs	Trephina Creek	C	,,	10
36	Ormiston Gorge	?	C	,,	13
37	18 mls. N. Alice Springs	16-mile Creek	C	,,	33
38	36 mls. N. Alice Springs	Burt Creek	C	,,	29
39	44 mls. on Harts Ra. Rd.	Gillen Creek (Sandover)	C	*eremica*	22

TABLE 1—*continued*

Site No.	Location	River or Creek	Lerps Present	Species	Number of Specimens
40	84 mls. E. Harts Ra. Police Station	Marshall River	C R	*eremica*	5
				blakei	4
				brimblecombei	2
41	81 E. Harts Ra. Police Station	Plenty River	C	*eremica*	14
				brimblecombei	2
				blakei	1
42	14 mls. S. Barrow Creek	?	C	*eremica*	3
43	25 mls. N. Barrow Creek	Taylor Creek	C	*eremica*	38
44	Wauchope	?	C	*eremica*	18
45	Devil's Marbles	—	C R	*eremica*	15
46	23 mls. N. Wauchope	McLaren Creek	C R	*eremica*	7
				brimblecombei	2
47	Daly Waters	?Katherine River	C?O	*blakei*	9
48	16 mls. S. Renner Springs	Tomlinson Creek	C	*blakei*	23
49	Attack Creek	Attack Creek	C R	*blakei*	18
50	6 mls. N. Tennant Creek	Tennant Creek	C O	*blakei*	6
				eremica	2
51	8 mls. E. Camooweal	?	C O R	*blakei*	5
52	62 mls. E. Camooweal	Buckley River	C O	*blakei*	2
53	3 mls. N. Mt. Isa	Leichhardt River	C	*blakei*	7
				brimblecombei	1
54	2 mls. E. Mt. Isa	Breakaway Creek	C O R	*blakei*	19
55	Urandangi	Georgina River	C O	*blakei*	34
				brimblecombei	1
56	66 mls. S. Dajarra	?	C R	*blakei*	17
				brimblecombei	2
57	Boulia	Burke River	C R	*blakei*	6
				brimblecombei	4
58	23 mls. SE. Springvale	Diamantina River	C R	*blakei*	1
59	104 mls. W. Windorah	Farrar's Creek	C R	*blakei*	1
60	7 mls. NE. Windorah	Cooper's Creek	C?O	*blakei*	18
				brimblecombei	2
61	Isisford	Barcoo River	C O R	*blakei*	9
62	10 mls. NW. Longreach	Dingo Crk. (Thompson R.)	C R	*brimblecombei*	2
63	Alice	Alice River	C O R	*blakei*	5
				brimblecombei	1
64	E. of Drummond Range	Medway Creek	C O R	*blakei*	4
				brimblecombei	1
From *E. tereticornis*					
65	Meteor Creek	Meteor Creek	C O R	*brimblecombei*	13
				blakei	3

Total specimens examined : 1082

Lerp shape : C = clover leaf ; O = oval ; R = round

All insect material has been placed in The Australian National Insect Collection, C.S.I.R.O., Canberra, A.C.T. Methods of storage and treatment of specimens for examination and identification were essentially as those previously recorded (Moore, 1961, 1964, 1970*a*).

A sample of buds, seed capsules and mature leaves, when each or all were available, was obtained from a selected tree of *E. camaldulensis* on which *Glycaspis* lerps occurred, at each collection site. Corresponding site numbers on aluminium labels were attached to the samples which have been lodged, together with relevant details of the sites, with the New South Wales National Herbarium, Royal Botanic Gardens, Sydney, N.S.W.

Results

A. *Glycaspis* spp. associated with *E. camaldulensis*.

An extensive area where the three *Glycaspis* spp. *blakei*, *brimblecombei* and *eremica* intermingle, was determined. This approximate area is delimited by the heavier outline in Fig. 1.

From the rearing of nymphs to the adult stage, it was found that two or more of these *Glycaspis* spp. were able to coexist and survive on the same tree. The non-selectivity between trees of *E. camaldulensis* by these three species in areas where they intermingle therefore lessens the likelihood that they indicate

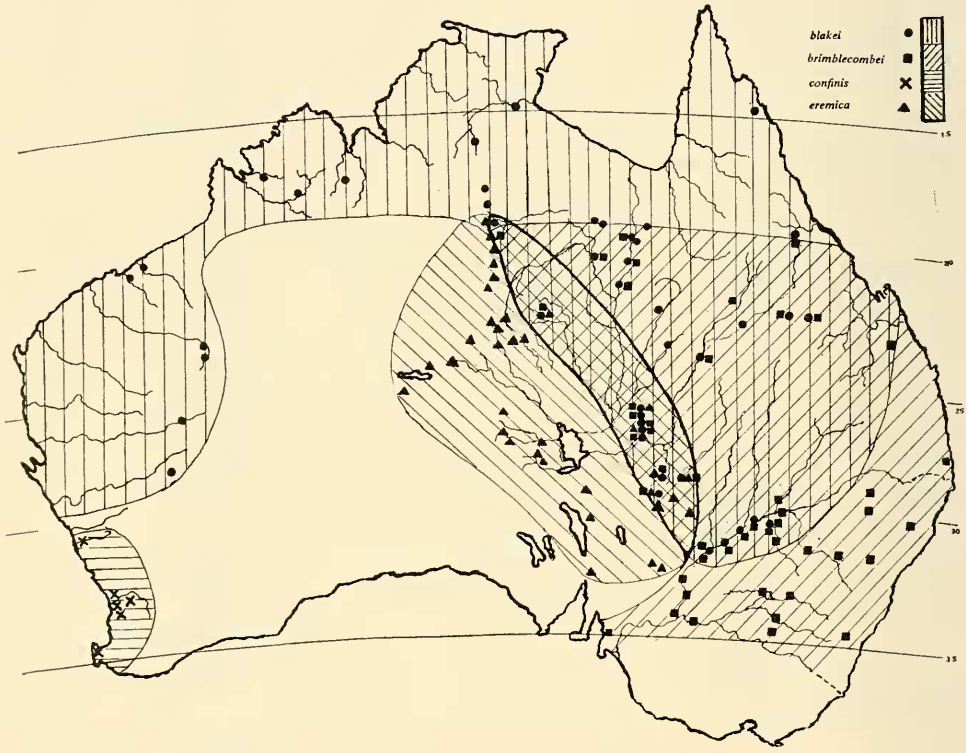

Fig. 1. Distributions of three *Glycaspis* spp. on *Eucalyptus camaldulensis*, and of *G. confinis* on *E. rudis* and *E. cornuta*.

separate taxa of their host plant, at least in that area of intermingling. Nevertheless, their known distributions and overlap may indicate, in a broad sense, the approximate areas of distribution for more than a single taxon of *E. camaldulensis*.

The typical shape of lerps constructed by *G. blakei* and *G. eremica*, atypical of those constructed by other species of *Glycaspis*, are illustrated in Fig. 2, and the general shape suggests the name " cloverleaf " lerps. Each lerp is constructed by a different nymph, and the figure illustrates the superimposed lerps of three nymphal instars. Lerps are usually white, or rarely yellow, and their composition appears similar to that of lerps of other species in the subgenus *Glycaspis*. The close phylogenetic relationship of these two species, as previously indicated (Moore, 1970*a*), is thus confirmed by the lerp shapes. A few lerps were different in shape, being more or less like a Maltese Cross (i.e. with two crossbars at right

angles) or single-bar-shaped. These aberrant lerp shapes were not investigated, but it is suggested that such atypical forms might result from parasitism of the associated nymph.

The distribution of *G. blakei* was not found to extend southwards beyond its previously determined southern limit at Wilcannia, New South Wales. It occurred in large numbers on *E. tereticornis* Sm. at Site 65 (Meteor Creek, Queensland), adult specimens of this species and of *G. brimblecombei* being reared from the sample tree. Although *E. tereticornis* is plentiful from that site eastward to the coast, an investigation of this area revealed no further cloverleaf lerps. The occurrence of *G. blakei* on *E. tereticornis* is a new host record for this species.

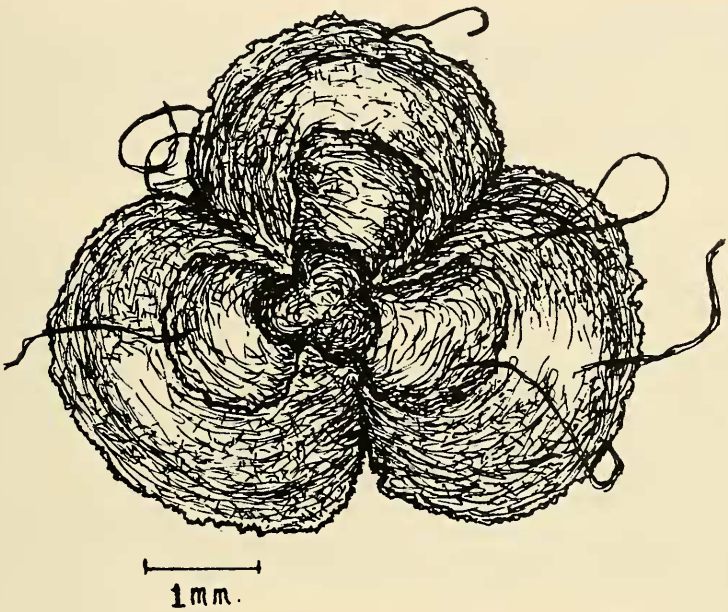

Fig. 2. Cloverleaf lerp typical of *G. blakei* and *G. eremica*.

Known only from west of the Darling River, *G. eremica* intermingles with *G. blakei* and *G. brimblecombei* at a few sites in the drier inland areas of the Northern Territory, Queensland, South Australia and New South Wales, although it occurs alone, throughout the greater portion of its range (Fig. 1).

The species *G. gradata* Moore, previously recorded as possibly occurring on *E. camaldulensis* and *E. largiflorens* F. Muell., was not obtained during this project. Its absence from the intensively sampled former host thus might be interpreted as indicating that its correct host is *E. largiflorens*, and from its distribution records, other closely related " box " species also. It is possible that adverse seasonal factors may have prohibited its occurrence on *E. camaldulensis* during these investigations, but this seems unlikely.

At Sites 1 to 10, round lerps were utilised for rearing *Glycaspis* spp. nymphs to the adult stage for determination of the species. Table 1 indicates that lerps of *G. amnicola* Moore intermingle with those of *G. brimblecombei* on the same tree. *G. amnicola* was previously recorded as constructing oval lerps, but it is now evident that many of the lerps of this species are round, as shown by emergences from the lerps used in the rearing of nymphs, and they are apparently indistinguishable from the round lerps of *G. brimblecombei*. It is maintained that some lerps of *G. amnicola* are oval, thus indicating a possible transitional evolution-

ary stage from the formation of round to oval lerps by nymphs of *G. amnicola*. Northwards from Site 8 (Tilpa) *G. amnicola* was replaced by *G. blakei*, and the former species now is known to coexist with *G. brimblecombei* from Euston on the Murray River, along the Darling River to Tilpa.

B. *Glycaspis* spp. associated with other hosts.

Additional collections for *Glycaspis* specimens were made from a number of other hosts. Results, arranged according to the subgeneric classification of *Eucalyptus* and the system of coded species of Pryor and Johnson (1971), are now given.

(i) Subgenus *Blakella*

Species BAA :A *Eucalyptus tessellaris* F. Muell. was sampled in several areas, but no *Glycaspis* specimens were obtained or lerps observed. It is now considered that this species is most unlikely to be a host of *Glycaspis* spp., even though it was recorded as a possible host of *G. brunneincincta* Moore (1970*a*). This conclusion is consistent with previously recorded results of collections from other eucalypt species in this subgenus (Moore, 1970*b*).

(ii) Subgenus *Eudesmia*

Species EAADC *E. odontocarpa* F. Muell. was sampled in three widely separated areas. No *Glycaspis* specimens or their lerps were obtained or observed, these results being consistent with those previously recorded (Moore, 1970*b*).

EAADE *E. gamophylla* F. Muell. was sampled in several areas with the same results. This project presented an opportunity to become well acquainted with this eucalypt in the field, and it is now almost certain that the plant previously collected from, at Joffre Falls, Western Australia (Moore, 1970*a*), was not *E. gamophylla* but probably SNABG *E. brevifolia* F. Muell. At that time, *E. gamophylla* in the field was not familiar to the writer.

EFAAA *E. similis* Maiden was intensively and extensively sampled in one locality, but no *Glycaspis* specimens were obtained, or their lerps observed.

Intensive sampling of EFABA *E. baileyana* F. Muell. in one locality produced the same result.

Within this subgenus, 11 of the 15 species have now been sampled for *Glycaspis* spp. which were obtained only from EAC:A *E. tetrodonta* F. Muell., EFC:A *E. miniata* A. Cunn. ex Schau. and EFC:B *E. phoenicea* F. Muell. (Moore, 1970*a*, 1970*b*).

(iii) Subgenus *Gaubaea*

GAA:A *E. curtisii* Blakely and White was intensively sampled in one area, but no *Glycaspis* specimens or their lerps were obtained or observed.

GAA:C *E. tenuipes* (Maiden and Blakely) Blakely and White was intensively sampled in one area, with the same results.

(iv) Subgenus *Monocalyptus*

Glycaspis specimens from MATEL *E. radiata* Sieber ex DC. collected by A. Yen of La Trobe University, at Healesville, Victoria, were identified as *G. endasa* Moore. This species was originally collected and named from *E.* "*robertsonii*" Blakely at Towamba, South Coast, New South Wales, by the writer; however, the trees in that area are *E. radiata* ssp. radiata.

(v) Subgenus *Symphyomyrtus*

Species SBA:C *E. raveretiana* F. Muell. Trees on Moore's Creek, and in the Botanic Gardens, Rockhampton, Queensland, were sampled for *Glycaspis* and their lerps, but no specimens were obtained or observed.

SIVEO *E. pachyphylla* F. Muell. was previously sampled (Moore, 1970*b*), when no *Glycaspis* specimens were obtained or lerps observed. During this project it was sampled in two widely separated localities where it was established that *Glycaspis* specimens of the *occidentalis* group were utilising it as host. The species obtained, which constructs round lerps, requires more study before it can be assigned a correct position within the *occidentalis* group of species.

SNABG *E. brevifolia* F. Muell. was sampled at Skull Creek, near Central Mount Stuart, Northern Territory. Adults collected were identified as *G. onychis* Moore, and this becomes the most southern locality where *G. onychis* has been obtained. The previous most southern locality was Joffre Falls, Western Australia.

SNEEB *E. tereticornis* Sm. At Site 65, intermingling round and cloverleaf lerps were collected from the sample tree, and nymphs reared to adults. The species were determined as *G. brimblecombei* and *G. blakei* respectively.

SNEEP *E. camaldulensis.* Additional to the species previously mentioned in this paper, the following *Glycaspis* spp. were obtained during net collections from this plant species :

G. cnecosia Moore from Sites 15, 18, 19, 31, 59, 60.

G. sudicola Moore from Sites 6, 23, 49.

G. froggatti Moore from Sites 32, 49, 54.

G. buxalis Moore from Site 25.

G. retrusa Moore from Site 51.

The sweeping of these species from the foliage of *E. camaldulensis* does not necessarily mean that the eucalypt is utilised as host by the *Glycaspis* species obtained ; e.g. it has been found that species accidental to the host may often be collected during periods of windy weather. The positions of trees in relation to each other and the prevailing wind direction are also contributing factors ; hence the large number of queried hosts recorded in Moore (1970*a*). It seems certain that none of the species *G. buxalis*, *G. retrusa* or *G. froggatti* utilise *E. camaldulensis* as host, when their previously recorded hosts are considered. *E. microtheca* F. Muell., which also occurred at each of these sites, is the probable host of these species.

SNEEX *E. exserta* F. Muell. Previously recorded from 34 miles north of Clermont, Queensland, adults of *G. exsertae* Moore were obtained from this host four miles west of Alice, Queensland, and it was verified that their lerps were round in shape. The original description of this species was based on one male specimen only (Moore, 1970*a*).

SUADE *E. microneura* Maiden and Blakely. *G. froggatti* was previously recorded from this host and eight other eucalypt species, from Nannine in Western Australia to Clermont, Queensland (Moore, 1970*a*). It has now been collected from this host at two miles east of Mt. Isa, Queensland, where it was verified that the shape of its lerp was round to oval, as previously recorded.

SUADJ *E. cyanoclada* Blakely. This eucalypt species previously had not been sampled for *Glycaspis* specimens. At 56 miles east of Frewena, Northern Territory, adults of *G. retrusa* were obtained during this project, but no lerps were found, although intensively sought.

SUG:A *E. cambageana* Maiden. *G. cnecosia* was collected from this, its originally recorded host, at 36 miles north of Biloela, Queensland, where its numerous round lerps occurred mainly on the twigs and blossoms, thus indicating its possible affinities with the *occidentalis* group of species.

SUP:Y *E. pruinosa* Schau. was again sampled for *Glycaspis* spp. but, as previously, no adults or lerps were obtained or observed.

(vi) *Melaleuca argentea* W. V. Fitzg.

Specimens of *G. devexa* Moore were obtained from this host at Moonal Creek, 28 miles south-east of Urandangie, Queensland, this record constituting a new host for *G. devexa*. The range of its previously recorded distribution is thus considerably extended.

Conclusion

The area where the three *Glycaspis* spp. on *E. camaldulensis* intermingle shows some correlation with the 31°C. summer isotherm. This isotherm extends from the approximate centre of the Northern Territory to the south-eastern corner of that State, the north-eastern corner of South Australia almost to the north-western corner of New South Wales, to south-west and central Queensland, passing from latitude c. 18° S. to c. 28° S., through the four areas of differing summer isohyets of 0 mm to 125 mm, 125 mm to 250 mm, 250 mm to 500 mm and 500 mm to 1000 mm. A temperature effect on the distribution limits of the three *Glycaspis* spp. is thus indicated as the most probable limiting factor.

Collections of the three *Glycaspis* spp. and the sampling of *E. camaldulensis* during this project were necessarily confined to the planned route. Presence or absence of the host on a discrete river or creek contacted at more than one locality, varied considerably ; e.g. although the host species was present at Sites 58 and 59, it was absent from the lower reaches of the same watercourse at Birdsville. Differing soil types appeared to be associated with this variability.

The atypical " cloverleaf " lerps of *G. blakei* and *G. eremica* suggest phylogenetic divergence of these two species from the remainder of the species which construct round, oval or rectangular lerps within the subgenus *Glycaspis*.

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